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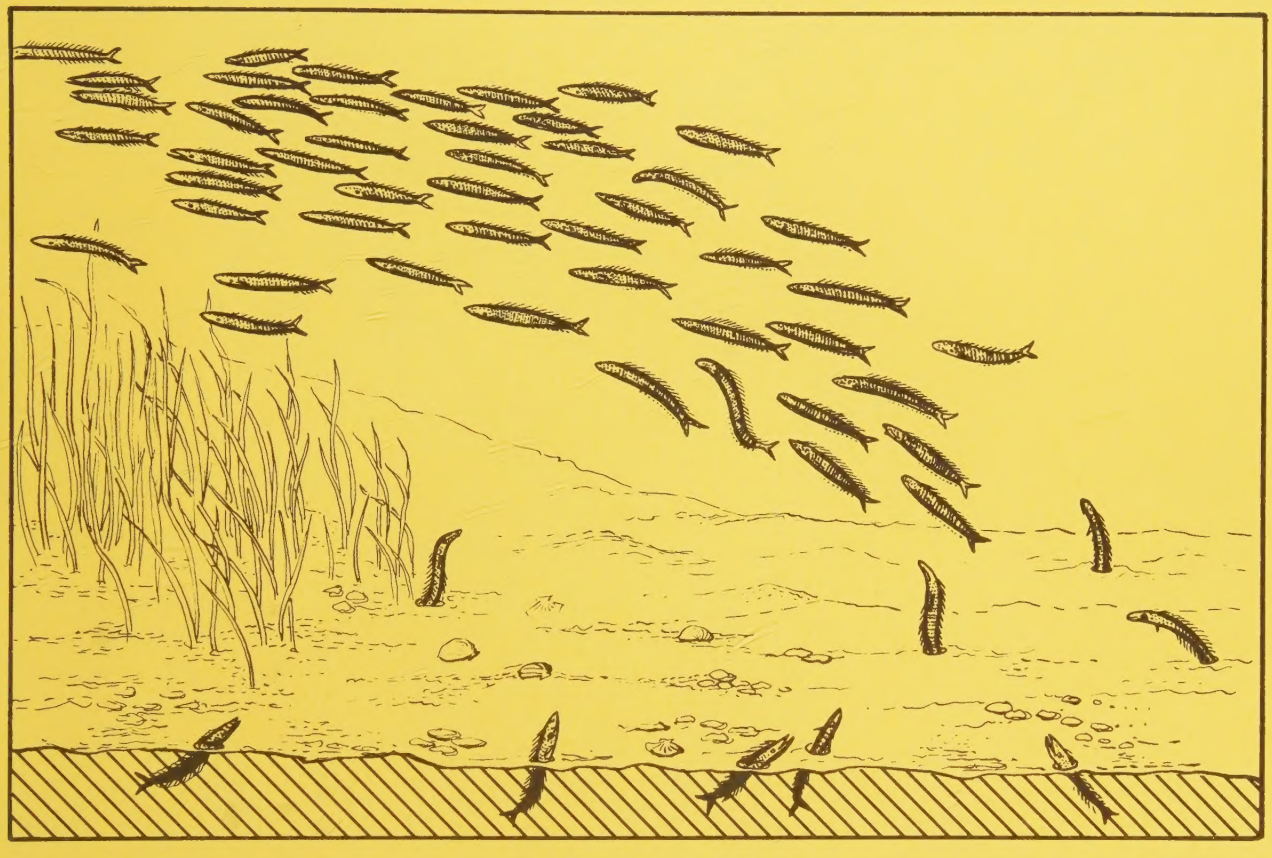
Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (North Atlantic)

SAND LANCE



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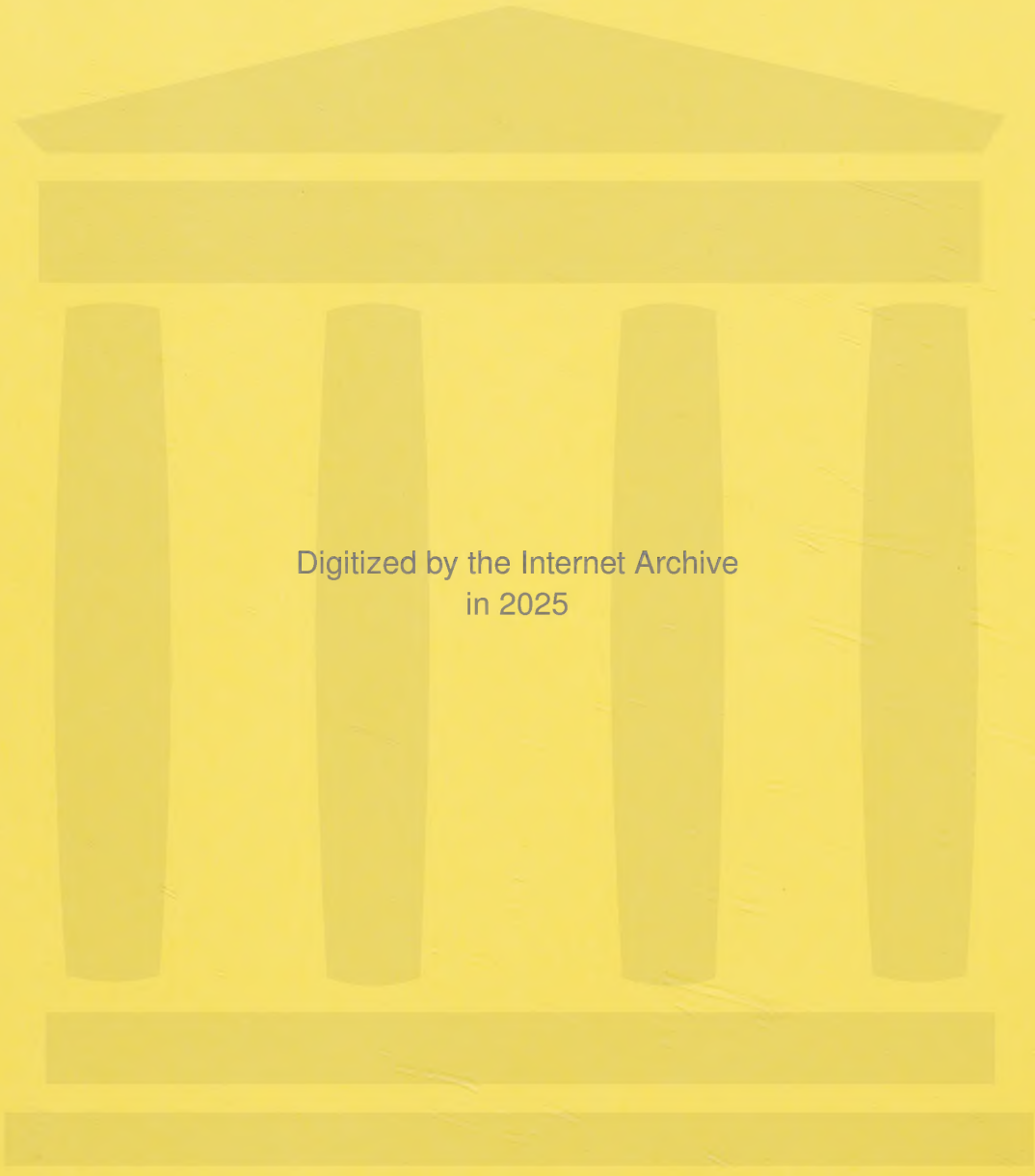

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Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (North Atlantic)

SAND LANCE

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PREFACE

This species profile is one of a series on coastal aquatic organisms, principally fish, of sport, commercial, or ecological importance. The profiles are designed to provide coastal managers, engineers, and biologists with a brief comprehensive sketch of the biological characteristics and environmental requirements of the species and to describe how populations of the species may be expected to react to environmental changes caused by coastal development. Each profile has sections on taxonomy, life history, ecological role, environmental requirements, and economic importance, if applicable. A three-ring binder is used for this series so that new profiles can be added as they are prepared. This project is jointly planned and financed by the U.S. Army Corps of Engineers and the U.S. Fish and Wildlife Service.

Suggestions or questions regarding this report should be directed to one of the following addresses.

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CONVERSION TABLE

Metric to U.S. Customary

Multiply	By	To Obtain
millimeters (mm)	0.03937	inches
centimeters (cm)	0.3937	inches
meters (m)	3.281	feet
kilometers (km)	0.6214	miles
square meters (m^2)	10.76	square feet
square kilometers (km^2)	0.3861	square miles
hectares (ha)	2.471	acres
liters (l)	0.2642	gallons
cubic meters (m^3)	35.31	cubic feet
cubic meters	0.0008110	acre-feet
milligrams (mg)	0.00003527	ounces
grams (g)	0.03527	ounces
kilograms (kg)	2.205	pounds
metric tons (t)	2205.0	pounds
metric tons	1.102	short tons
kilocalories (kcal)	3.968	British thermal units
Celsius degrees	1.8(°C) + 32	Fahrenheit degrees

U.S. Customary to Metric

inches	25.40	millimeters
inches	2.54	centimeters
feet (ft)	0.3048	meters
fathoms	1.829	meters
miles (mi)	1.609	kilometers
nautical miles (nmi)	1.852	kilometers
square feet (ft^2)	0.0929	square meters
acres	0.4047	hectares
square miles (mi^2)	2.590	square kilometers
gallons (gal)	3.785	liters
cubic feet (ft^3)	0.02831	cubic meters
acre-feet	1233.0	cubic meters
ounces (oz)	28.35	grams
pounds (lb)	0.4536	kilograms
short tons (ton)	0.9072	metric tons
British thermal units (Btu)	0.2520	kilocalories
Fahrenheit degrees	0.5556(°F - 32)	Celsius degrees

CONTENTS

	Page
PREFACE	iii
CONVERSION FACTORS	v
ACKNOWLEDGMENTS	vi
NOMENCLATURE/TAXONOMY/RANGE	1
MORPHOLOGY/IDENTIFICATION AIDS	1
REASON FOR INCLUSION IN SERIES	4
LIFE HISTORY	4
Spawning	4
Fecundity and Eggs	4
Larvae	4
Juveniles and Adults	5
GROWTH CHARACTERISTICS	5
FISHERY	6
ECOLOGICAL ROLE	6
ENVIRONMENTAL REQUIREMENTS	6
Temperature	6
Salinity	6
Habitat	7
Other Environmental Factors	7
LITERATURE CITED	9

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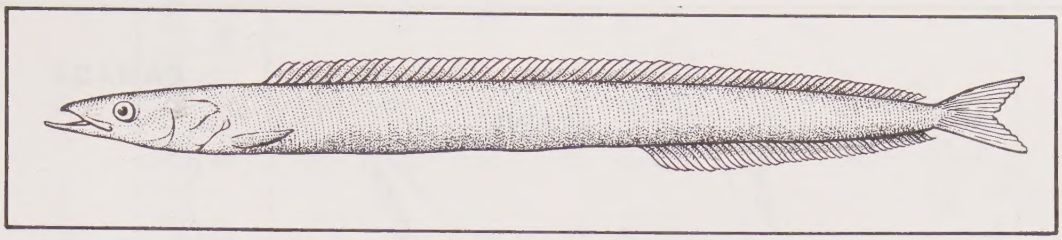

Figure 1. Sand lance.

SAND LANCE

NOMENCLATURE/TAXONOMY/RANGE

Scientific name..... Ammodytes spp.
Preferred common name.....Sand lance (Figure 1)
Other common names..... Sand eel, sand launce, lant, lance, equille, northern sand lance (A. dubius), American sand lance (A. americanus)
Class..... Osteichthyes
Order..... Perciformes
Family..... Ammodytidae

Geographic range: From northern Labrador and Hudson Bay south to Cape Hatteras (Bigelow and Schroeder 1953; Richards et al. 1963; Liem and Scott 1966) and from upper estuaries (Norcross et al. 1961) to the edge of the Continental Shelf (Richards and Kendall 1973)(Figure 2). This genus is most abundant, however, along the inner half of the Continental Shelf and is most commonly associated with sandy substrates (Bigelow and Schroeder 1953; Grosslein and Azarovitz 1982).

MORPHOLOGY/IDENTIFICATION AIDS

Meristic values of sand lance vary greatly with latitude as well as with distance from shore at the same latitude (Backus 1957; Richards et al. 1963; Winters 1970; Scott 1972; Pellegrini 1976). Richards et al. (1963) demonstrated various types of spatial changes in the genus Ammodytes from the northwest Atlantic and distinguished groups with high, intermediate, and low meristic counts. The intermediate group was split, and fish with high to intermediate counts were named A. dubius and those with low to intermediate counts were named A. hexapterus (= A. americanus). The range of meristic characteristics and overlap between species of this genus over a wide geographic area were significant (Table 1). As a result of this variation, sand lance in the North Atlantic area off the coast of the U.S. (Ammodytes spp.) will be covered as a combined group in this profile.

The body of the sand lance is small, elongate, and slender. Body depth is uniform from the opercular region to the beginning of the anal fin. Body depth then begins to taper towards the caudal peduncle. The tail is forked. The anal fin originates under the 29th or 30th dorsal fin ray. The lateral line is straight. The mouth is terminal with lower jaw projecting forward and no teeth (Liem and Scott 1966). Fin ray counts vary as in Table 1.

Color of individual fish is variable. The dorsal surface can be olive, brown, or bluish green. Lower sides are silver with a dull white ventral region. Some individuals have a steel-blue iridescent longitudinal stripe.

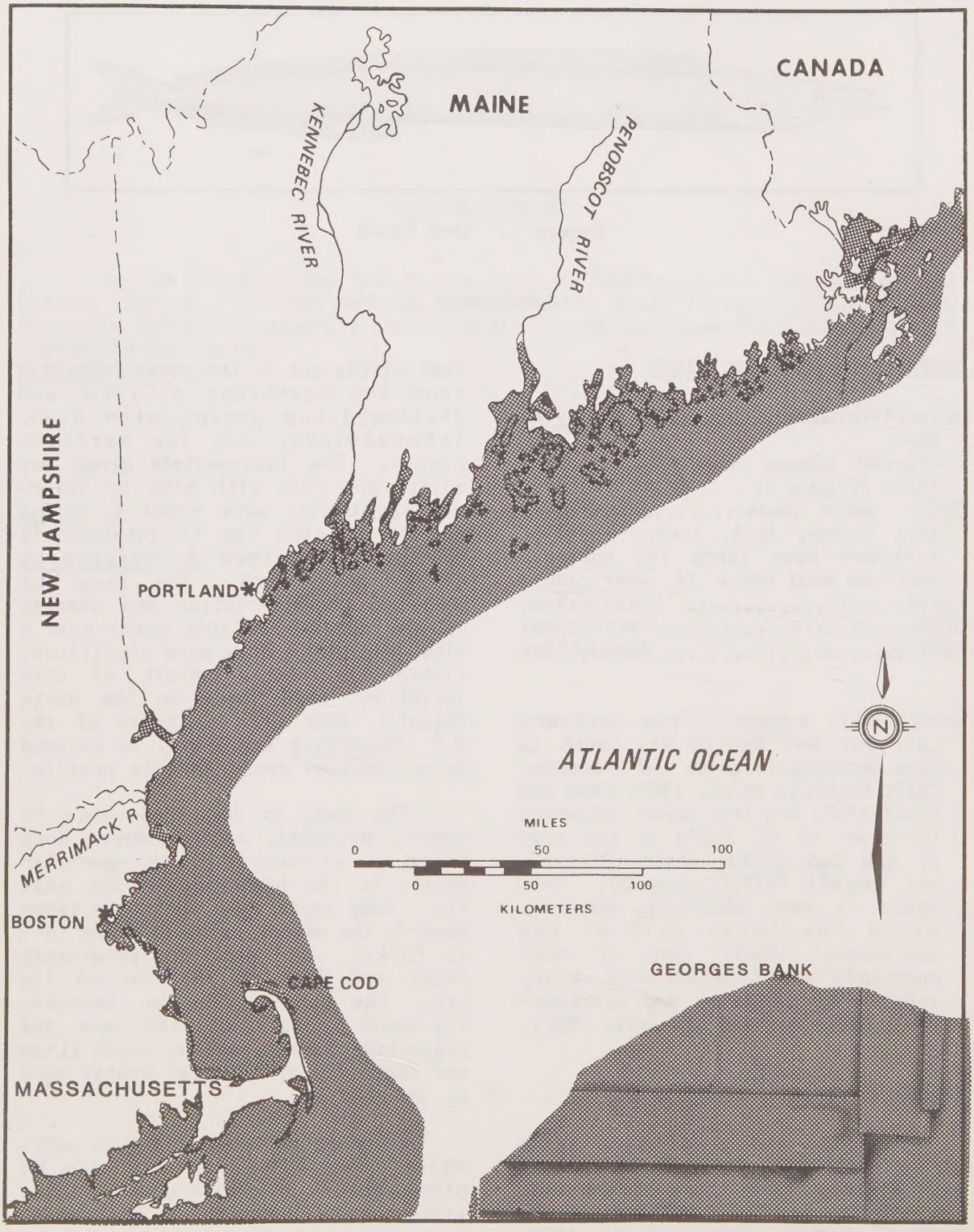

Figure 2. Distribution of sand lances along the North Atlantic coast.

Table 1. Meristic values of Northwest Atlantic species of Ammodytes (adapted from Pellegrini 1979).

Species	No. in sample	Vertebrae		Dorsal fin rays		Anal fin rays	
		Range	Mean	Range	Mean	Range	Mean
Ammodytes hexapterus (Richards et al. 1963) East coast of North America	1020	61-73		51-62		23-33	
A. hexapterus (Scott 1972) Newburyport, Massachusetts	73	64-71	68.1	55-61	57.6	27-32	29.4
A. americanus (Backus 1957) Labrador	12	62-69	67.2	56-60	58.5	28-31	29.6
A. americanus adults (Pellegrini 1976)	700	63-73	67.9	52-62	57.4	26-32	29.4
A. americanus juveniles (Pellegrini 1976)	610	64-73	68.0	53-62	57.8	27-33	29.7
A. dubius (Richards et al. 1963) East coast of North America	—	65-78		56-68		27-35	
A. dubius (Leim and Scott 1966) East coast of Canada	—	71-75		62-68		30-35	
A. hexapterus (Winters 1970) Offshore Newfoundland	—	70-78		60-69		30-37	
A. hexapterus (Winters 1970) Inshore Newfoundland	—	63-72		52-60		25-33	

Sand lance eggs, larvae, and postlarvae were described by Norcross et al. (1961), Williams et al. (1964), Richards (1965), and Smigielski et al. (1984), and can be distinguished from those of other species on the basis of morphology.

REASON FOR INCLUSION IN SERIES

Sand lance are widespread along the northeast coast of the U.S. (Sherman et al. 1981; Morse 1982). They are abundant and are an important prey species for many predatory fishes important to commercial and recreational fisheries and are also important prey for marine mammals. Sand lance occur in estuarine, open coastal, and offshore habitats. Contiguous overlapping populations provide linkages between these habitat types and coastal regions.

LIFE HISTORY

Spawning

Sand lance mature during their first or second year (Westin et al. 1979), and males reach maturity several months before females (Scott 1968). Spawning occurs principally from November to March (Bigelow and Schroeder 1953; Norcross et al. 1961). Larval fish survey data indicate that spawning occurs principally inshore although evidence exists of some offshore spawning activity (Richards and Kendall 1973; Sherman et al. 1981; Sherman et al. 1984). Sand lance lay demersal eggs that are deposited on or in sand substrates or on gravel surfaces (Ehrenbaum 1904; Williams et al. 1964). Sand lance larvae are distributed over a wide area of the shelf in winter (Sherman et al. 1984).

Fecundity and Eggs

Westin et al. (1979) showed that sand lance in the Merrimack River exhibited size specific fecundity. The model which describes this relationship is: $f = 0.328\ l^{3.857}$ where f is fecundity (number of eggs) and l is fork length (cm). Estimates of weight loss during spawning of females range from 30% to 45% (Scott 1972; Westin et al. 1979; Smigielski et al. 1984).

Sand lance eggs range in diameter from 0.67 to 1.03 mm and have a single bright yellow oil globule (Williams et al. 1964; Smigielski et al. 1984). Eggs hatch from November to May when water temperatures drop below 9 °C (Wheatland 1956; Norcross et al. 1961; Richards and Kendall 1973). Incubation times of eggs spawned in the laboratory ranged from 30 days at 10 °C to 82 days at 2 °C (Smigielski et al. 1984).

Larvae

Larvae are approximately 3 to 4 mm in length at hatching. After a planktonic stage of 2 to 3 months (Grosslein and Azarovitz 1982), during which they grow to about 35 mm (Scott 1973a), they become semidemersal. Larvae reared in captivity at 7 °C exhibited schooling behavior at a size of 35 to 40 mm 90 days after hatching, and first burrowed into the sand at 133 days after attaining a size of 35 to 40 mm (Smigielski et al. 1984).

Larvae are most abundant off the mouths of major estuaries but are common out to the edge of the Continental Shelf (Norcross et al. 1961; Richards and Kendall 1973). Major concentrations of larvae have consistently occurred in the Georges Bank and the Nantucket Shoals to Long Island, New York, regions since 1976 (Sherman et al. 1981; Morse 1982). Norcross et al. (1961) found that larvae increased in size in samples taken along nearshore to offshore transects, suggesting that the larvae may be able to undertake directed migrations away from the shore.

Richards (1976) reported the occurrence of heterotypic schools of sand lance and herring (Clupea harengus harengus) postlarvae. The ubiquity of this behavior is unknown. Heterotypic schooling has been reported in several diverse species groups (Nursall and Pinsent 1969; Ogden and Erlich 1977; Frank and Leggett 1983; Auster 1984). This behavior is believed to be an adaptive response to predation: increased school size reduces the probability of predation on any individual.

Sand lance larvae feed diurnally. Their diet consists of phytoplankton, invertebrate eggs, and copepod nauplii. As the fish increases in size, phytoplankton such as peridinians decrease in importance and copepod nauplii increase. When larvae become about 21 mm long, their diet consists mostly of adult copepods (Covill 1959).

Juveniles and Adults

Juvenile and adult sand lance have generally been found in schools during the day. Meyer et al. (1979) observed school sizes ranging from about 100 to tens of thousands of fish. We have observed schools of about 20 to 100 individuals along the coast. This observation is consistent with those reported for Hyperoplos lanceolatus and A. tobianus off Europe by Kuhlmann and Karst (1967), who observed school sizes of 30 to 300. In general, school size seems to be smaller in shoaler water, increasing as water depth increases. However, schools may occur at any depth in the water column (Meyer et al. 1979).

The shape of sand lance schools is generally compressed vertically and lengthwise. In shallow water, schools tend to be more compressed vertically and longer than in deeper water (Kuhlmann and Karst 1967; Meyer et al. 1979).

Sand lance are generally found over sandy substrates. Sand is used as a refuge. Individual fish have been observed to burrow into the sand and remain either partly buried (with either anterior or posterior body parts exposed) or totally buried after emerging headfirst and then backing up (Meyer et al. 1979). European sand lance species are reported to school diurnally and seek refuge in sand substrates at night. Schools reform at dawn (Kuhlmann and Karst 1967).

Copepods are the major prey of juvenile and adult sand lance (Reay 1970; Scott 1973b; Meyer et al. 1979). The inclusion of less important prey items such as crustacean larvae (Scott 1973b) and chaetognaths (Meyer et al. 1979) in the sand lance diet probably reflects the utilization of locally abundant prey.

GROWTH CHARACTERISTICS

Reay (1970) reported that 1- to 3-year-old fish dominate sand lance populations but individuals can live to 9 years of age and grow to a total length of 37 cm (Scott 1968). Comparison of length-at-age data suggests that growth rate increases from the New York Bight to the Nova Scotia banks (Grosslein and Azarovitz 1982).

Pellegrini (1976) found that sand lance from the Merrimack River, Massachusetts, had a weight-length relationship described by the model:

$$\log W\ (g) = -2.718 + 3.098 \log L\ (mm)$$

This model agrees with weight-length relationships found by Scott (1972) for sand lance on the Newfoundland Grand Banks and Emerald Bank.

Growth is fastest during the first year of life and slows with increasing age. The Von Bertalanffy growth model for sand lance from the

Merrimack River, generated from the Ford-Walford relationship, is

$$l_t = 24.08 \quad (1-e^{-0.2508(t+0.5970)}).$$

This model includes both males and females because their growth rates did not differ significantly (Pellegrini 1976).

FISHERY

The use of sand lance in the U.S., limited to occasional use in the baitfish industry, has not been extensive. Annual landings between 1965 and 1973 ranged from 0 to 75 metric tons (Grosslein and Azarovitz 1982). Historically, Bigelow and Schroeder (1953) reported that more than 30 metric tons (67,800 pounds) were landed in 1919 and over 9 metric tons (20,000 pounds) in 1946, from traps in Massachusetts. National Marine Fisheries Service survey data indicate that the sand lance population in the northwest Atlantic increased greatly after 1974 (Grosslein et al. 1980; Sherman et al. 1981). No plans now exist for the management of sand lance in U.S. waters of the northwest Atlantic.

ECOLOGICAL ROLE

Sand lance are a major link between zooplankton production and fishes of commericial importance. They have been found in the stomachs of a wide variety of species, including Atlantic cod, Gadus morhua; haddock, Melanogrammus aeglefinus; silver hake, Merluccius bilinearis; white hake, Urophycis tenuis; yellowtail flounder, Limanda ferruginea; and longhorn sculpin, Myoxocephalus octodecemspinosus (Scott 1968, 1973b; Bowman et al. 1976; Bowman and Langton 1978). They are also important prey of whales and porpoises (Bigelow and Schroeder 1953; Overholtz and Nicolas 1979; Hain et al. 1982). The importance of sand lance as prey of cod increases from south to north (Grosslein and Azarovitz 1982).

Although no specific data exist on diseases of sand lance in the North Atlantic, other studies in the literature suggest that certain trends have been discerned in pollution-related diseases. Sand lance in coastal waters of northeastern United States are associated with surficial sediments through their burrowing behavior. In fishes other than sand lance, fin necrosis has been associated with high coliform counts in coastal waters (Mahoney et al. 1973) and with high concentrations of heavy metals in sediments (Carmody et al. 1973). The frequency of skin tumors in geographically separated populations of flatfishes has been correlated with environmental rather than with genetic factors (Stich et al. 1976). The relationships discerned in these studies may apply to sand lance populations as well.

ENVIRONMENTAL REQUIREMENTS

Temperature

Sand lance occur along the North American coast from 35°N to 69°N. Temperatures within this latitudinal range vary widely. During the time of egg development, bottom water temperatures can be near 0 °C (Richards et al. 1963; Richards and Kendall 1973). Scott (1968) reported that sand lance were taken from the Nova Scotia banks at temperatures ranging from −2 to 11 °C, but they were most abundant between 3 and 6 °C. No records of an upper temperature limit have been published. Reay (1970) reported that A. tobianus along the south coast of England is active at temperatures as high as 18 °C.

Salinity

Tolerance of fluctuations in salinity apparently decreases with increasing age. Sand lance larvae

have been found in waters with salinities less than 1.8 ppt although only a small percentage were taken in samples at salinities less than 30 ppt (Norcross et al. 1961). Richards et al. (1963) reported that sand lance juveniles and adults occur in salinities ranging from 26 to 36 ppt.

Habitat

Sand lance occur throughout the water column over sandy substrates into which they burrow (Bigelow and Schroeder 1953; Reay 1970; Meyer et al. 1979). The sand lance burrows for rest and escape from predators; hence much time may be spent within the substrate, isolated from the water column. Relatively high bottom current velocities must therefore be present to maintain aeration of the interstitial water. The interaction of current velocity with substrate type in keeping interstitial water oxygenated is more critical in defining proper habitat than is the range of substrate particle sizes (Reay 1970).

Other Environmental Factors

European studies have reported on the light-mediated diel cycle of activity in other sand lance species. Direct underwater observations by Kuhlmann and Karst (1967) showed that sand lance (H. lanceolatus and A. tobianus) are diurnal schoolers, resting in the sand in groups at night. At dawn, schools re-form and begin feeding. In laboratory studies of A. marinus, swimming activity was high at light levels of 1000 and 100 lux but was greatly reduced at levels below 10 lux (Winslade 1974). In the same study, it was found that the threshold light intensity for swimming activity in the field was approximately 100 lux, and that buried sand lance may be able to detect light, via the pineal gland, to respond to changes in light intensity.

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16. Abstract (Limit: 200 words)

Species profiles are literature summaries on taxonomy, morphology, range, life history, and environmental requirements of coastal finfishes and shellfishes. They are designed to assist in environmental impact assessment. The systematic classification of the sand lances Ammodytes americanus and Ammodytes dubius is confusing because of overlapping meristic values. In this report, all sand lances in the North Atlantic area off the coast of the United States are treated as a combined group (Ammodytes spp.). Sand lances occur in estuarine, open coast, and offshore habitats. They are important prey to many commercially and recreationally valuable fish and marine mammals. Spawning occurs principally inshore between November and March. Larvae are found along the coasts to the edge of the Continental Shelf. Sand lances occur in schools of from tens to tens of thousands of individuals. They are planktivorous predators; copepods are their major prey item. To rest and to take refuge from predators, sand lances burrow into sand substrates. One to three-year-old fish dominate populations. Growth rate probably increases from the New York Bight to the Nova Scotia banks. Exploitation of sand lances off the Northeast coast of the United States is presently only for baitfish.

17. Document Analysis a. Descriptors

Estuaries	Life cycles	Food chains
Marine fishes	Growth	Temperature
Salinity	Contaminants	Feeding habits

b. Identifiers/Open-Ended Terms
Sand lance
Ammodytes
Spawning

c. COSATI Field/Group

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